Determination of Thermosetting Composites Properties for Design of Autoclave Curing Process

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The autoclave process is used in the composite manufacturing industry to produce fiber reinforced composite materials on the base of glass, carbon and polymer fiber and thermosetting epoxy resin matrix. In this process fiber mats impregnated with unreacted-thermosetting resin (prepreg) are laid up on tool, which is then covered with a variety of materials, and the set up is put into the autoclave for processing.

At computer simulating and design of process of heat transfer and curing of composites it is necessary to use mathematical model of the process and numerical value of its parameters. Heat and mass transfer in curing media are described by the system of equations of energy, conservation of mass, impulse, state of volatile components, rheology equation of state and kinetic equation.

For research of thermophysical, kinetic and other properties of composite materials during cure computer aided investigation is worked out, that includes special measuring device simulating symmetric heat transfer inside the unbounded plate. The method of integral characteristics was used for the thermophysical properties determination and with the help of this method calculating formulae and algorithms of experimental data processing were obtained that are constituent of the software basis for computer-aided investigation and design. Kinetic parameters such as activation energy and kinetic function for the cure equation were obtained by equal value extent of conversion method.

Investigated thermophysical properties and kinetic parameters of thermosetting composites in addition with some limitations on the curing process are using as mathematical model parameters for designing the optimum curing cycles. For monitoring and control of curing process dielectric measurements were possible to be used. Dielectric measurements were found to correlate well with measurements of degree of cure.

Typical examples of curves calculated on the base of experimental data for thermophysical, kinetic and dielectric parameters of the composites are shown.